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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

The Relationship of Air Conditioning to Rust Prevention

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS
FOR
AIR CONDITIONING AND HUMIDITY CONTROL MACHINERY

COMPRESSORS

REFRIGERANT	TYPE OF COMPRESSOR	TEXACO RECOMMENDATION
"FREON" GROUP	Rotary	TEXACO Capella Oil D
	Centrifugal	TEXACO Capella Oil D
	Reciprocating	TEXACO Capella Oil D or E
METHYL CHLORIDE	Reciprocating	TEXACO Capella Oil C or D
CARRENE NO. 1 OR NO. 2	Centrifugal	TEXACO Capella Oil D
CARBON DIOXIDE	Reciprocating	TEXACO Capella Oil D or E
AMMONIA	Reciprocating	
	In Force-Feed or Gravity Systems	TEXACO Capella Oil D or E
	In Splash Systems	TEXACO Capella Oil C

ELECTRIC MOTORS, FANS AND BLOWERS

RING OILED	
Normal Temperatures	TEXACO Capella Oil C or D
Low Temperatures	TEXACO Capella Oil A or B
BALL AND ROLLER BEARINGS	
Oil Lubricated	TEXACO Capella Oil B or C
Grease Lubricated	
Light to Medium Duty	TEXACO Starfak Grease No. 2
Heavy Duty	TEXACO Starfak Grease No. 3
WICK OR WOOL YARN SYSTEMS	TEXACO Capella Oil B or C

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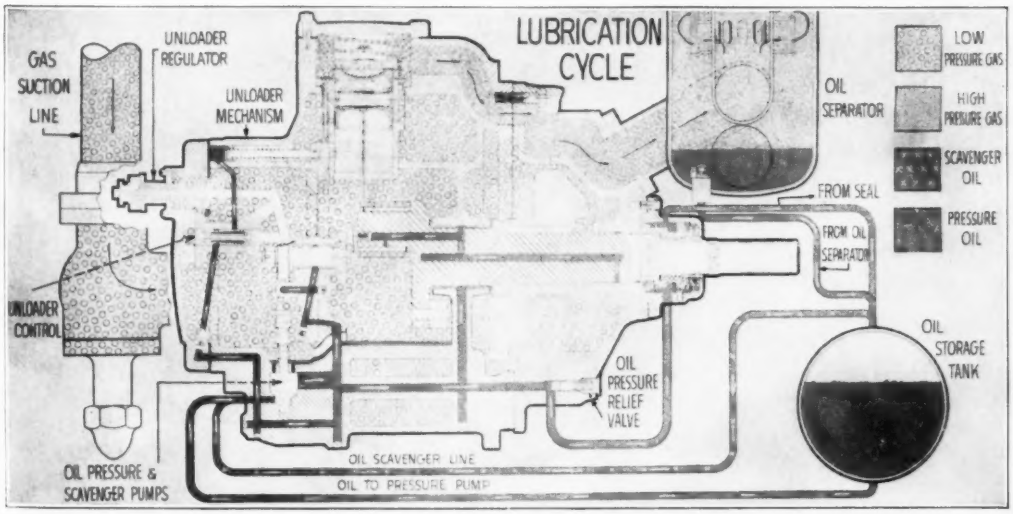
The Relationship of Air Conditioning to Rust Prevention

PREVENTION of rust or corrosion of metals during the course of machining has been the ideal of the metal worker for years. The benefits, in the form of more assured precision, fewer rejects and better lubrication were apparent. But the means available were limited.

As the interest in this problem increased, the metal worker progressed through a routine of studying the rust-preventive properties of cutting, grinding and slushing oils, the value of using gloves, the merit of acid-testing employees and the use of various chemicals as pore-closures to prevent hand or finger perspiration. All are of some value. Cumulatively, they are very helpful in eliminating the human element from the problem.



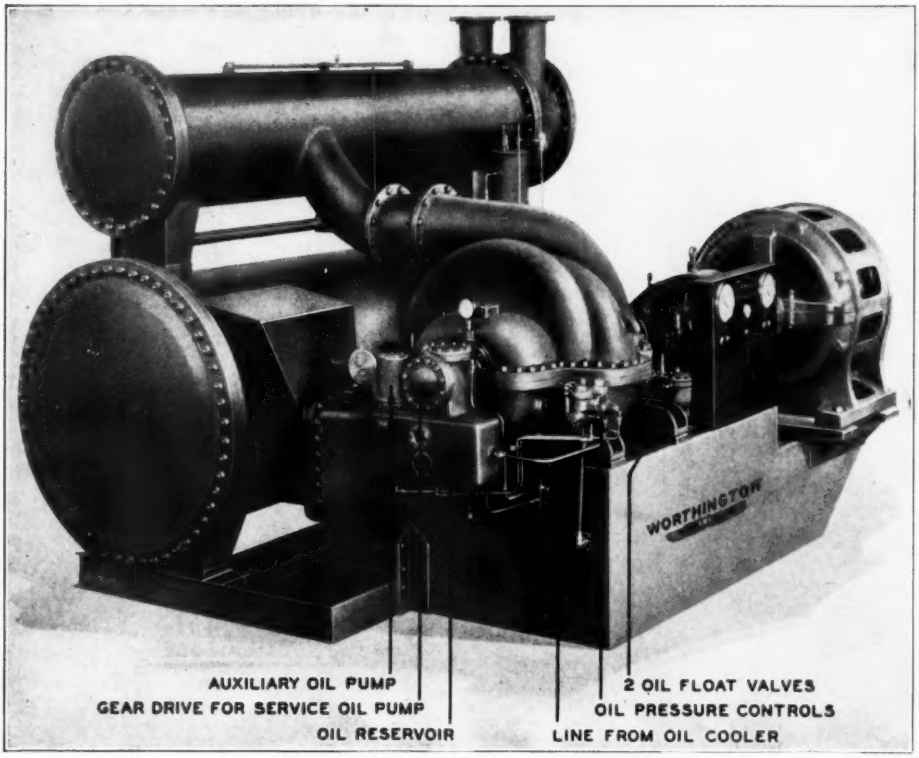
Courtesy of Chrysler Corporation, Airtemp Division

Fig. 1—Lubricating cycle of Chrysler's Airtemp radial compressor showing direction of flow of oil, and essential equipment.

Atmospheric humidity, however, presented a variable which used to be impossible of control. It was partially offset by the protection afforded by the cutting or grinding oils, but never entirely obviated. So, when air-condi-

tioning and means for controlling humidity was perfected, it presented an entirely new concept to the problem of rust prevention.

The value of controlled humidity has been appreciated in the development of our program of national defense. It has been particularly applicable to the aircraft engine and ball or roller bearing industries where production must not be retarded by alteration in the surface of materials which might cause rejects. When rejects are encountered scrapping of the parts in question may be the only recourse—



Courtesy of Worthington Pump and Machinery Corp., Carbondale Division

Fig. 2—The Worthington-Carbondale centrifugal compressor showing external parts of the lubricating system.

the production schedules are so exacting that refinish is usually impracticable.

In studying this problem of rust and corrosion prevention, one is primarily concerned with steel, though corrosion or staining of certain bronzes which are used in the assembly of ball and roller bearings must also be considered. In turn, although high humidity along with temperature change, and acid perspiration are the most contributing factors, acid atmosphere is also highly objectionable.

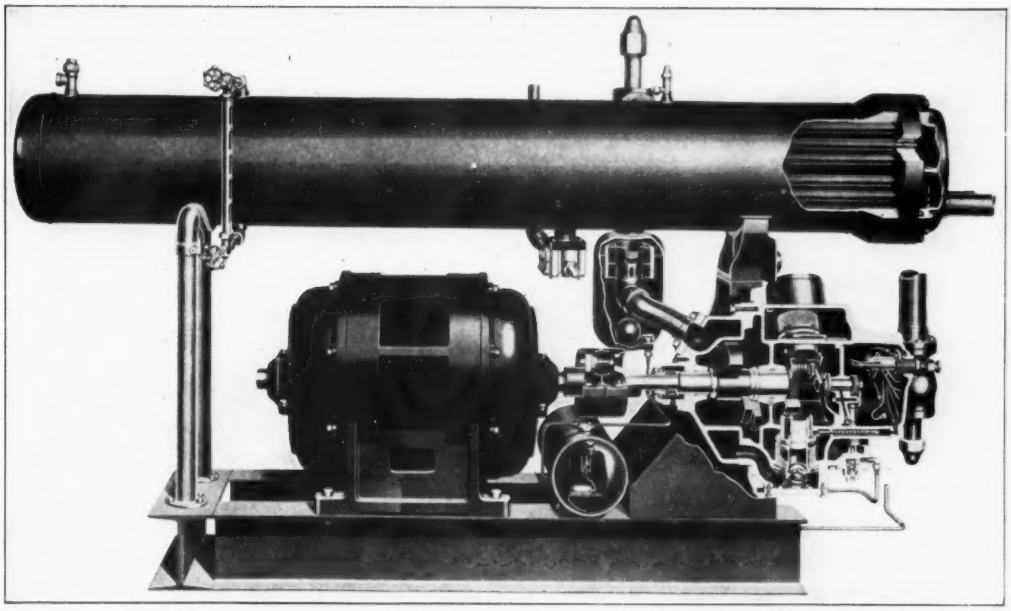
The air-conditioning industry is cooperating most effectually in solving this problem. Obviously it requires the installation of humidity-control equipment and adequate means of temperature control, at least in the final assembly and inspection parts of the plant.

Temperature control is particularly important in aviation research where stratosphere temperature conditions may often have to be simulated for test purposes. Here certain component parts must be run-in on test equipment to study the protective and lubricating ability of the lubricants which are to be used in flying service.

The objective is attained by using cold rooms which can be chilled down to around minus 75 degrees Fahr. Here controllable pitch propeller mechanisms, and bearing assemblies can be run under conditions so closely akin to stratosphere flying that very convincing data can be developed.

So, refrigeration becomes an equally important counterpart in this problem of protection and production of national defense materials.

The design of buildings or rooms which can be adapted to humidity and temperature control is a function of the architect, the ventilating expert, the insulating engineer and the air conditioning engineer. Air-flow must be positively regulated and directed; drafts must be minimized; moisture from any source must be



Courtesy of Chrysler Corporation, Airtemp Division

Fig. 3—Cutaway of the Chrysler-Airtemp unit showing cylinder and valve arrangement, the oil separator and other details.

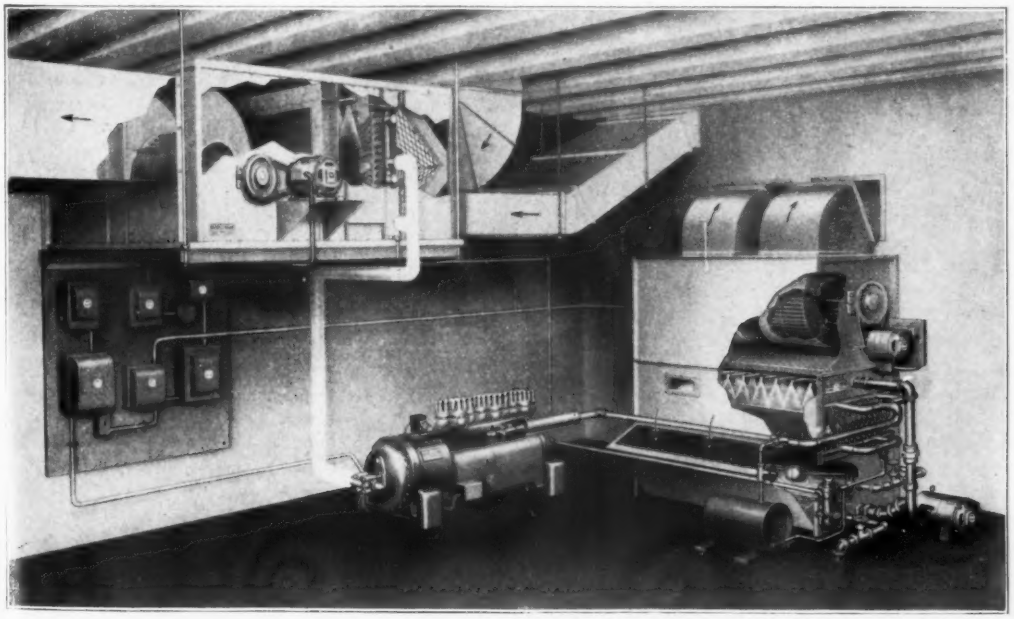
controlled. In operation this is maintained by the humidity-control equipment.

Refrigerating machinery and heat exchanging equipment are employed for temperature control. It is practicable to combine humidity and temperature-control equipment in a unit assembly which accomplishes the desired purpose very satisfactorily. So, air-conditioning has become a vital adjunct to national defense.

COMPRESSOR LUBRICATION MUST BE CONTROLLED

Lubrication of compressors, motors and air conditioning equipment becomes a vital factor in this program. Machinery must not fail, yet it can fail very easily if it is not properly lubricated. Then, entire production programs can be affected.

So, it becomes necessary for the maintenance



Courtesy of Westinghouse Electric and Manufacturing Company

Fig. 4—Phantom view of a comp'ete Westinghouse Air Conditioning system, showing details of the various component parts.

personnel to know more about the details of refrigeration compressor lubrication; more about the relation to the refrigerants in common usage; more about the characteristics which a compressor oil should possess.

Contact between the refrigerant and the compressor lubricating oil is very likely in any completely enclosed unit which is designed for splash or force feed circulation of the oil from the crankcase or oil sump. It all depends upon the type of compressor and the method of sealing. Normally it will be more apt to occur in a reciprocating machine than in a centrifugal unit. As chlorinated or fluorinated refrigerants such as Carrene, methyl chloride or one of the "Freon" group are widely used in this service, the possible reduction in oil viscosity must always be considered.

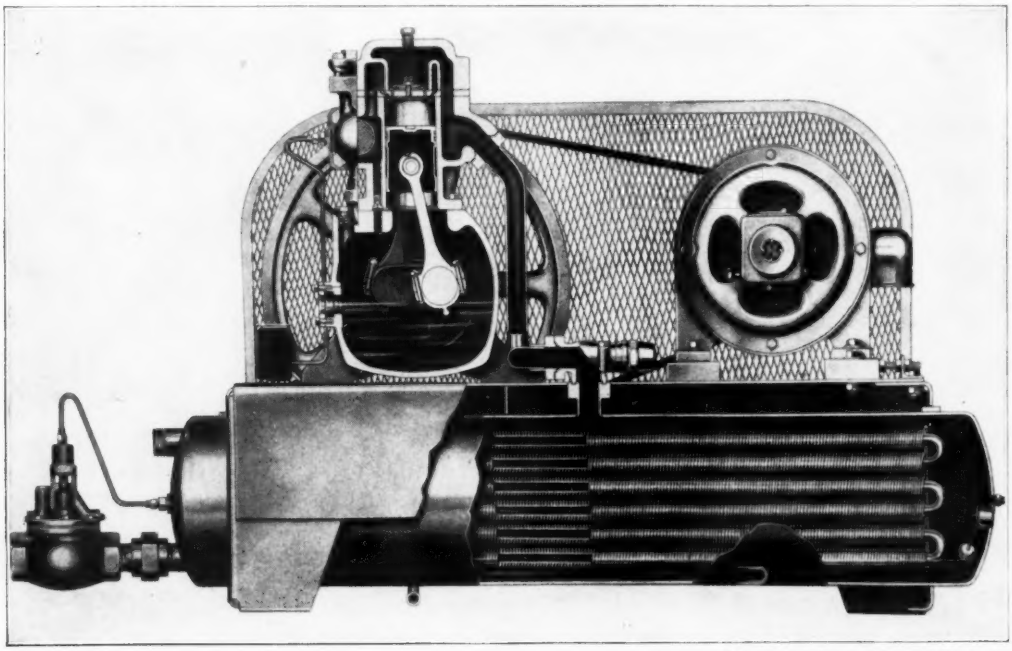
The centrifugal compressor involves the lubrication of the bearings of the rotating elements. Here bearing protection and seal-maintenance against loss of vacuum are the primary functions of the oil. Nor will there be any appreciable decrease in viscosity due to mixture with the refrigerant for this can occur only past the seals.

Viscosity reduction may be of considerably more concern, however, in the operation of reciprocating compressors. Here the method of lubrication must be carefully considered. Wherever splash lubrication is involved, an appreciable amount of the oil may be drawn over to the high pressure side of the system to become mixed with the refrigerant. There is also the possibility that the refrigerant-content of the oil in the crankcase will be appreciable, especially where Carrene, methyl chloride, or "Freon" are used, all of which are completely miscible with petroleum oils. Ammonia, however, is relatively insoluble.

Control of Refrigerant Vapors

For this reason the refrigerant must be carefully controlled. Some units provide for direct return to the crankcase of any oil (plus refrigerant) as removed by the oil separator. In others an oil level regulating device is employed, although this may not be necessary if care is observed not to initially over-charge the machine with oil. There has also been a trend on larger types of industrial air-conditioning machines to go to pressure lubrication to obtain better control of oil circulation.

Compressors of the reciprocating type can also be built so that the refrigerant vapors are kept entirely apart from the crankcase. Construction of this nature largely eliminates the possibility of the oil becoming mixed with an excess of refrigerant. This enables the oil to maintain its original viscosity, or merely to follow the normal reduction in viscosity which would take place as the crankcase comes up to average operating temperature. This condition will prevail in the enclosed crankcase machine

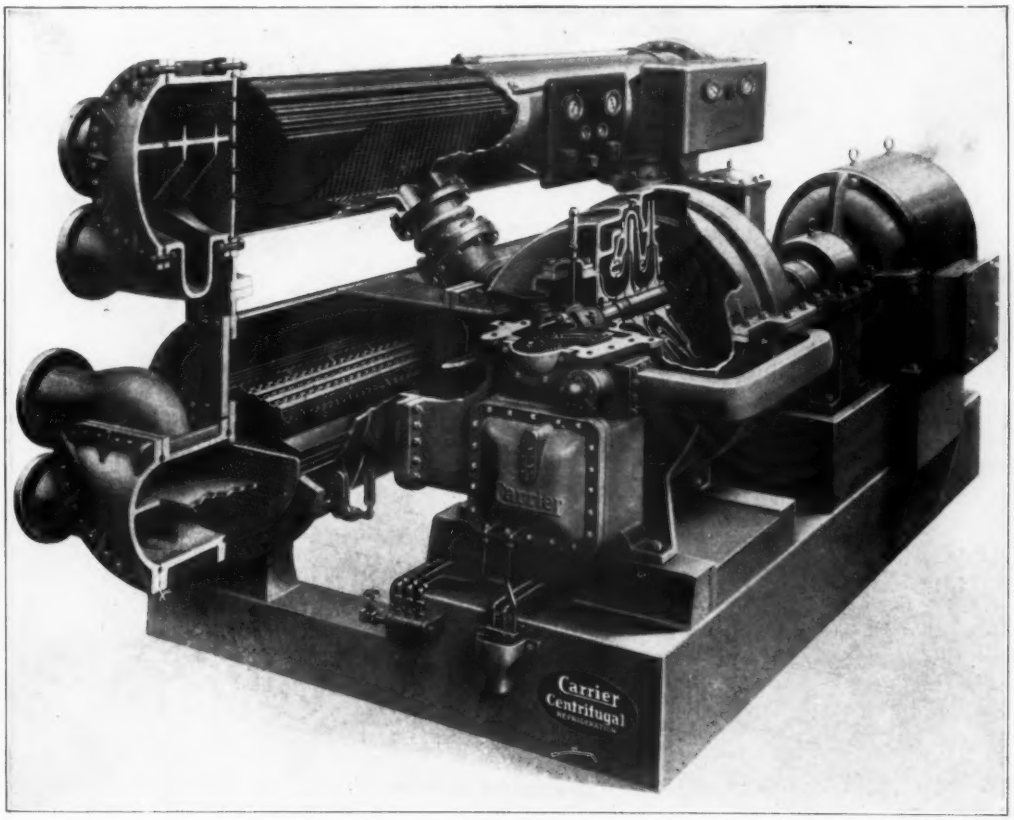


Courtesy of General Electric Company

Fig. 5—The G-E Scotch Giant condensing unit. This is designed for splash lubrication as indicated by oil in the base of the compressor.

equipped with trunk-type pistons and designed for pressure lubrication. The oil pump maintains a positive circulation of oil without excessive splash effect; therefore, foaming is markedly decreased. Reduction of oil splash in turn reduces the tendency of any refrigerant present to mix with the oil supply, especially as there is no circulation of refrigerant vapors within the crankcase.

Location of the oil pump in such a machine must, of course, be carefully studied; some authorities recommend that it be at the lowest point in the crankcase to insure against loss of suction and the resultant reduction in volume of oil circulated which might readily lead to impaired lubrication. Others have studied and applied the principles of dry sump lubrication to good advantage, using a pressure pump for oil circulation and a scavenging pump for the return.



Courtesy of Carrier Corporation

Fig. 6. Details of a Carrier centrifugal refrigerating machine. This unit is used extensively in the metal trades to cool water required for cooling and humidity control.

Central Station Service

In service where considerable tonnage is involved, the possibility of reduction of the oil viscosity by mixture with the refrigerant is further reduced by using the crosshead type of vertical compressor, or the horizontal double-seal stuffing box machine. In these units the refrigerant vapors are kept entirely clear of the base or crankcase of the machine, being returned directly to the cylinder block. As a result there is but little chance of the oil in the case becoming mixed with refrigerant; so here, again foaming is eliminated along with reduction in viscosity.

Where lubrication of the crankcase elements or external parts is maintained entirely independent from the cylinders, it is customary to provide for injection of a certain amount of oil into the refrigerant return line or directly to the cylinders and stuffing boxes to take care of piston and valve lubrication and to protect the cylinder walls against scoring. This oil can be subsequently separated from the refrigerant by judicious installation of the oil separator or a special type of oil reclaiming device.

DESIGNING FOR LUBRICATION

Compressor lubrication is being studied more and more with regard to its relation to capacity

or efficiency. This holds true regardless of the type of lubricating system employed. There must be adequate lubrication, but not a continual excess, for immediately this latter occurs, the possibility of oil slugging will develop. The capacity of the crankcase is especially important in the splash-lubricated machine; the larger the crankcase the greater the possibility of reducing pressure variations and carrying a lower oil level.

In the application of force-feed lubrication to compressors of the "Freon" and methyl chloride type an external plunger-actuated, belt-driven pump was first used to deliver oil to all the working parts of the unit. Later the gear-driven pump, direct-connected to the crankshaft was developed. This takes oil from the base of the compressor through filters of heavy felt and steel gauze. Thence, it is pumped through a hollow crankshaft and connecting rods to all main bearings within the compressor.

Other developments went one step further in their application of force-feed lubrication by providing for a dry crankcase, using two oil pumps, one for pressure delivery, the other for scavenging the crankcase.

The crankcase oil level can be also controlled and pressure variations and the tendency towards foaming reduced by fitting the compressor with an exterior tube connection from the oil sump to the pump. Oil is delivered through the crankshaft to the crankpin and main bearings, and via a separate copper tube connection from the crankpins to the piston pins.

Another type of full pressure lubricated vertical reciprocating compressor is unique for its utilization of two separate lubricating systems: (1) a gear-type oil pump with filter attachment for delivery of oil under uniform pressure to all the bearings; and (2) a mechanical lubricator for measured delivery of oil to the cylinders and piston rod packing. Flood lubrication of the cylinder walls is prevented by the use of piston rod packing where the rods pass from the cylinders into the crankcase. The latter, in turn, being entirely enclosed and pressure-tight, precludes any possibility of dilution of the crankcase oil by the refrigerant, or loss of oil by entrainment with the latter.

It is obvious that the intricacy of the lubricating system will depend upon the type and capacity of the compressor. It has already been stated that the centrifugal machine requires only that the bearings of the rotor be lubricated. Simultaneously, however, the oil performs an additional function in maintaining an automatic oil seal against loss of vacuum.

Reciprocating compressors, on the other hand, present more parts to be lubricated and require circulation of oil. This is accomplished by splash or force feed. The idea of splash lubrication was first taken from early automotive practice, some very unique means being provided by certain manufacturers to assure of positive circulation, especially to the cylinder walls. For example, the cutting of grooves in the sides of the pistons to develop a positive

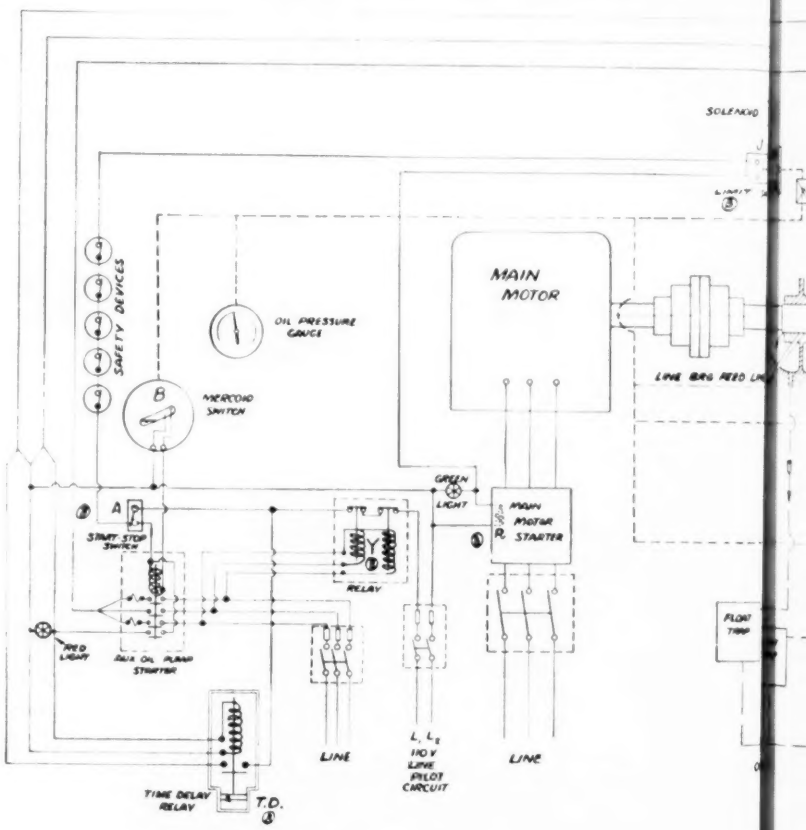
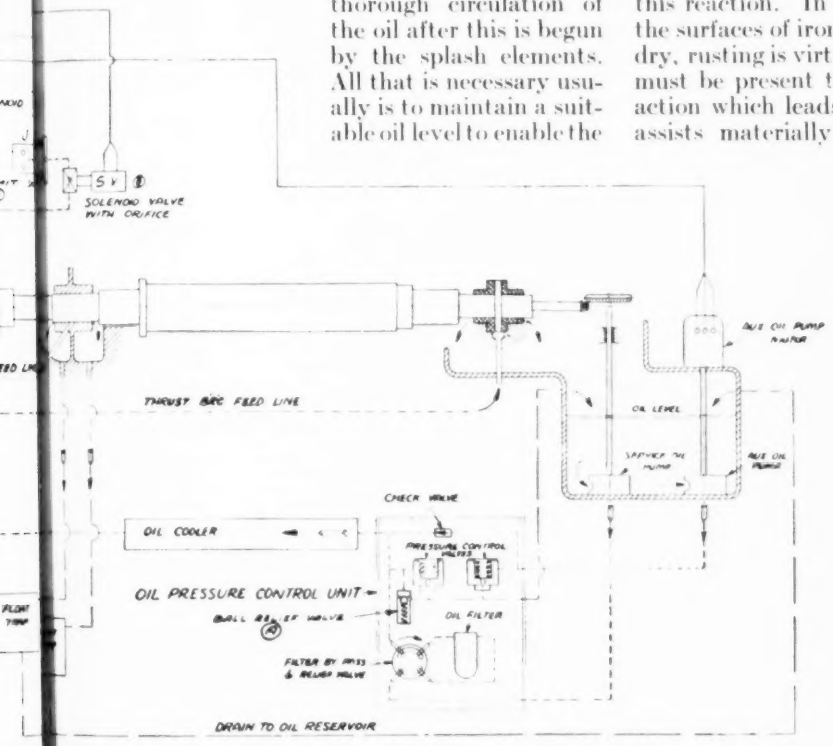


Fig. 7—The oiling system of the Worthington centrifugal compressor. Prior to starting the ma[chine] which is on as long as and whenever the auxiliary oil pump is running. This pump produces an o[il pressure] made which closes the pilot circuit for the main starter through various safety devices. It also flas[hes a red] the service oil pump, which is geared to the compressor shaft, produces a higher oil pressure than [the] intermediate level which occurs when the main motor is shut down or the oil service for some reas[on has] light flashes to indicate some emergency in the lubricating system.

oil supply, using special oil slinger paddles attached to the eccentric to splash oil onto the cylinder walls and into the reservoirs which lead to the bearings. Another design embodies a special oil feed into the piston itself to assure that this latter will be self-lubricated.

Starved lubrication is a remote possibility in a splash lubricated machine provided the parts are designed for thorough circulation of the oil after this is begun by the splash elements. All that is necessary usually is to maintain a suitable oil level to enable the splashers to dip to a sufficient extent at each throw of the crankshaft.



Courtesy of Worthington Pump and Machinery Corp., Carbondale Division

...iliary oil pump is started. The running of this oil pump is indicated by the flashing of a red light ...sufficient magnitude to lubricate the bearings and open up the seal. When this occurs, a contact is ...ght which indicates that everything is ready to start the main motor. As the compressor speeds up, ... oil pump cuts out. This pump remains shut down until for any reason the oil pressure falls to the ... the auxiliary oil pump starts again to maintain lubrication of the machine, meanwhile the red

RUST PREVENTATIVES

As the primary purpose of air-conditioning and humidity control in defense is to assist in the prevention of rusting or corrosion of machine parts, it is fitting to discuss the basic cause of rust; also those precautions which should be taken in the handling of materials which are subject to rust or corrosion. This is especially important in preparing sheet steel or steel shapes for shipment before it is possible to handle them under controlled moisture conditions. It is equally as important to prevent rusting at this stage as it is after the steel has been fashioned into finished parts.

Oxidation and Moisture Cause Rust

In brief, rusting of iron or steel is the result of oxidation (at normal temperatures) in the presence of moisture. It is obvious, therefore, that high humidity conditions will accelerate this reaction. In fact, if it is possible to keep the surfaces of iron or steel materials absolutely dry, rusting is virtually impossible, for moisture must be present to complete the oxidizing reaction which leads to rust. Humidity control assists materially in the attainment of this objective.

How Moisture is Present

Frequently, however, water must be used in the preliminary preparation of the bulk materials, as in the rolling of steel. Later, moisture may be present due to incomplete drying or to condensation, especially in a humid atmosphere when normal temperature drop takes place.

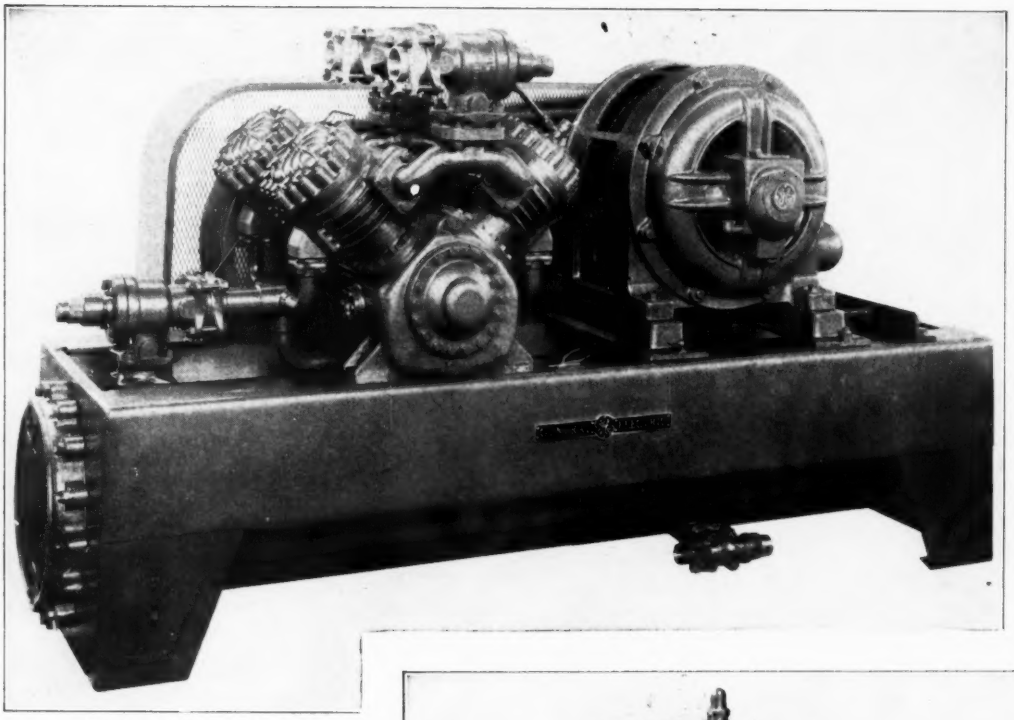
Moisture is especially likely to be present when any drying operation is carried out by direct contact with live steam. Under such conditions a final treatment of the parts with hot dry air will effectively remove any final traces of moisture. Condensation can be retarded by keeping metallic parts warmer than the surrounding air.

After drying, the surfaces should be treated with a suitable rust preventative which will completely cover them during storage; this will keep moisture from actual contact in case the parts are exposed.

As steel progresses in its transition from the stock received from the rolling mill to engine and machine parts, the manufacturer finds it more and more practicable to develop and maintain a condition of complete surface dryness by means of temperature and humidity control.

The Detriments of Rust

When industry was producing under "business as usual" procedure rust, was unsightly, also it reduced the sales value of any iron or



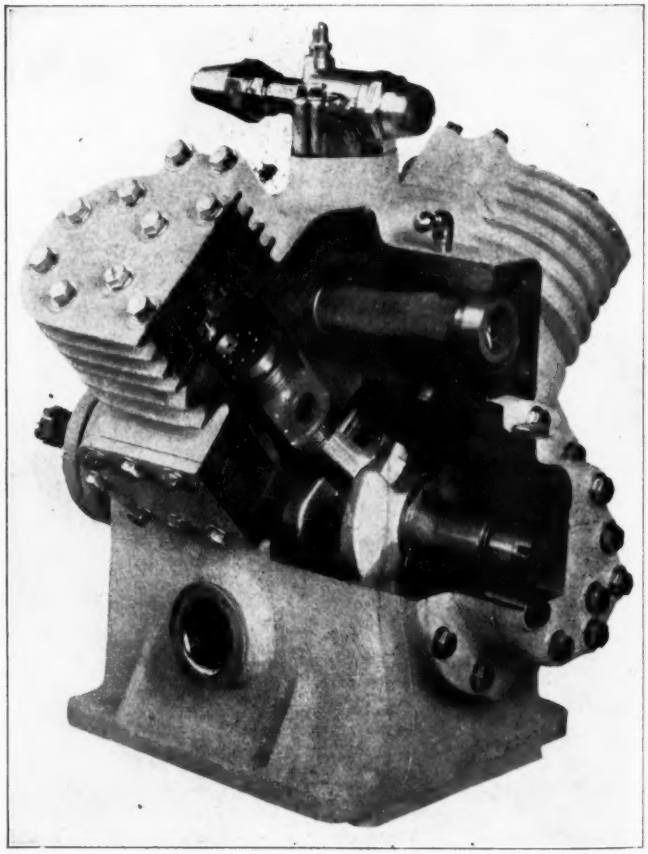
Courtesy of General Electric Company

Fig. 8—External view of the G-E Scotch Giant condensing unit.

steel article on which it had formed, even though it might have had no appreciable effect upon the size or strength. Today, however, rust is a detriment because it slows up production, for machinery built of precision parts cannot use these parts where the size might be affected by even a thousandth of an inch due to rust or corrosion.

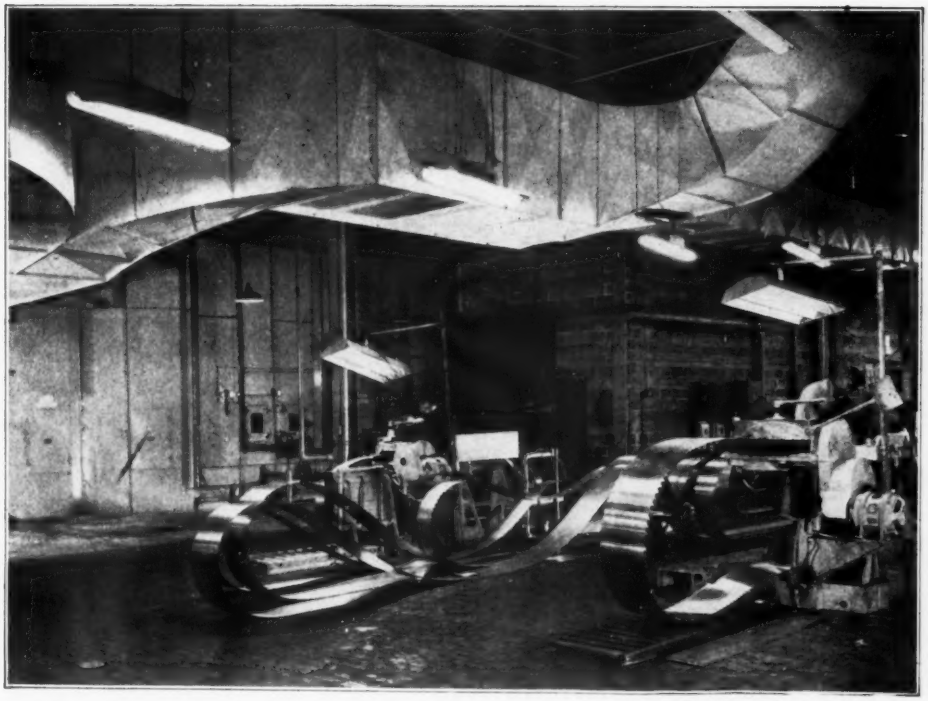
Means of Protection

So we are definitely interested in rust prevention. Research has proved that rust can be prevented by drying and coating steel surfaces with a protective film of petroleum base. The materials employed are termed slushing oils. During the research period a wide variety of such oils were developed, and used with more or less success. More recently the composition and rust-preventing ability of many of these compounds have been evaluated. Coincident with this work it was necessary to identify the various types of rust. Each had to be isolated, its cause investigated and the best means of prevention developed.



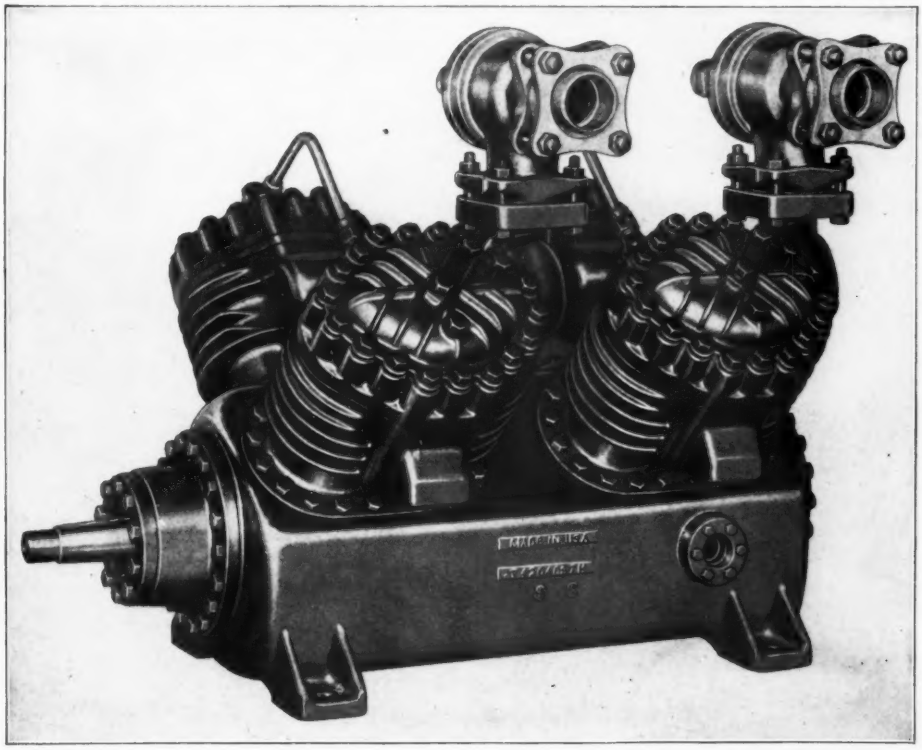
Courtesy of Carrier Corporation

Fig. 9—Showing details of a Carrier compressor. Note oil pump at the end of the shaft.



Courtesy of Carrier Corporation

Fig. 10—View in a large saw plant, where controlled atmospheric conditions are used.



Courtesy of General Electric Company

Fig. 11—Side view of a G-E, CM-124 refrigerating compressor. Note sight glass for oil level indication.

Slushing Oil Characteristics

As a result of this research, it was concluded that an effectual slushing oil for rust prevention should

1. Be easy to apply.
2. Give maximum protection against contact of the surface with air.

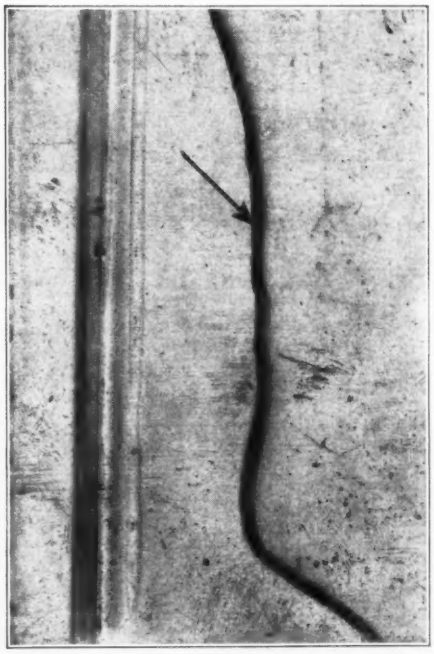


Fig. 12—Showing a line of rust which formed about two inches in from the edge of a steel sheet; caused by condensed moisture creeping in from the outside edge.

3. Furnish lubrication between the metal parts during bulk handling (as in the case of steel sheets) to prevent scratching or marking of the surfaces when normal rubbing occurs.
4. Be easy to remove when this protection is no longer required.

Oils of low to medium viscosity meet these requirements most effectually. The viscosity range being from 35 to 250 seconds Saybolt Universal at 100 degrees Fahr. Straight mineral oils, or specially compounded rust-proofing oils of petroleum base are most widely used for this purpose.

Straight Mineral Oils

Oils of this nature are very widely used in the steel industry. They are usually well refined products of paraffin or naphthene base containing no fatty oil or other ingredient. Straight mineral oils afford good protection and lubrication of steel surfaces during shipment and handling, and limited protection during storage; in other words, unless moisture conditions are extreme, when water will penetrate the oil film, wet the surface and permit oxidation to develop which results in rust spots. For this same reason some attempt has been made to control the year-round temperature and humidity in plants where steel for precision usage must be stored in considerable volume prior to usage.

Special Rust-Proof Compounds

Otherwise it is necessary to use a specially prepared rust-proof material. These products are composed chiefly of low viscosity petroleum lubricating oils or volatile thinners mixed with smaller amounts of other materials which will increase the protection against rust. When a thinner is used, it acts as a solvent to carry and spread uniformly the rust-preventing material. Rust-proofing oils as used for slushing steel sheets or shapes usually range in viscosity as indicated above. Other more viscous products of the nature of light greases or petrolatums are, however, used for coating certain other steel materials such as anti-friction bearings.

Fig. 13—Showing how fingerprints caused by operators handling steel with perspiration on the hands can develop rust.

The materials which are added to special rust-proofing oils are of the following general nature:

1. Fatty compounds of various kinds
2. Soaps soluble in water
3. Soaps not soluble in water

4. Metallic compounds (organic)
5. Mineral oil derivatives.

All of these added materials, if present in sufficient quantities and if prepared in the proper manner, will impart good rust-proofing qualities to the oils. Care should always be exercised in selecting any such material to be sure that it is chemically stable and will not oxidize to form corrosive materials.

Lanolin, lard oil, and other fatty oils give slushing oils greater properties of adhesion to the steel. They also tend to form emulsions with any moisture that may be present, thus keeping the water from wetting the steel, thereby preventing rust. Some fatty oils, however, upon long contact with metal are not entirely stable; they tend to oxidize, forming fatty acids which may after long storage corrode the metal, and cause yellow designs to form over the surface.

By special treatment, certain of these products can be made very resistant to oxidation; they have been found quite satisfactory over long periods of storage.

Soaps which are soluble in water are of value

Fig. 14—Showing thin lines of rust caused by lime deposits remaining on steel sheets after they had been neutralized. Rust formed directly under streaks of lime.

in that they will emulsify with any moisture coming into contact with the metal. Soaps which are insoluble in water are of value in that they increase the adhesiveness of the oil for steel.

Some metallic compounds possess inhibiting qualities in the presence of moisture.

Slushing oils containing from ten to thirty per cent of a suitably prepared rust preventative mixed with a volatile thinner appear to give excellent rust-proofing results. After application the solvent evaporates, leaving a

Fig. 15—Showing streaks of rust caused by moisture on steel sheets which had not been thoroughly dried before applying slushing oil.

thin layer of rust preventative which is very adhesive, and which is highly resistant to moisture, thus preventing rust formation. These oils range in viscosity from 35 to 70 seconds Saybolt at 100 degrees Fahr.

Where thinners are used, they should have a flash point sufficiently above room temperature to minimize any possibility of fire hazard.

Removal of Rustproofing Oils from Steel

One of the most important considerations in the use of a rustproofing oil is whether or not it can be easily removed from steel when removal is desired.

Many concerns which process steel have their own specifications for slushing or rustproofing oils, and these oils are usually chosen not only for their rustproofing qualities, but also for their ease of removal by the particular method employed.

Wherever fabricated steel parts are to be enamelled, lacquered, or possibly electroplated before being assembled into final form, it is necessary usually to completely remove all oil

before any of these surface treatments can be satisfactorily done.

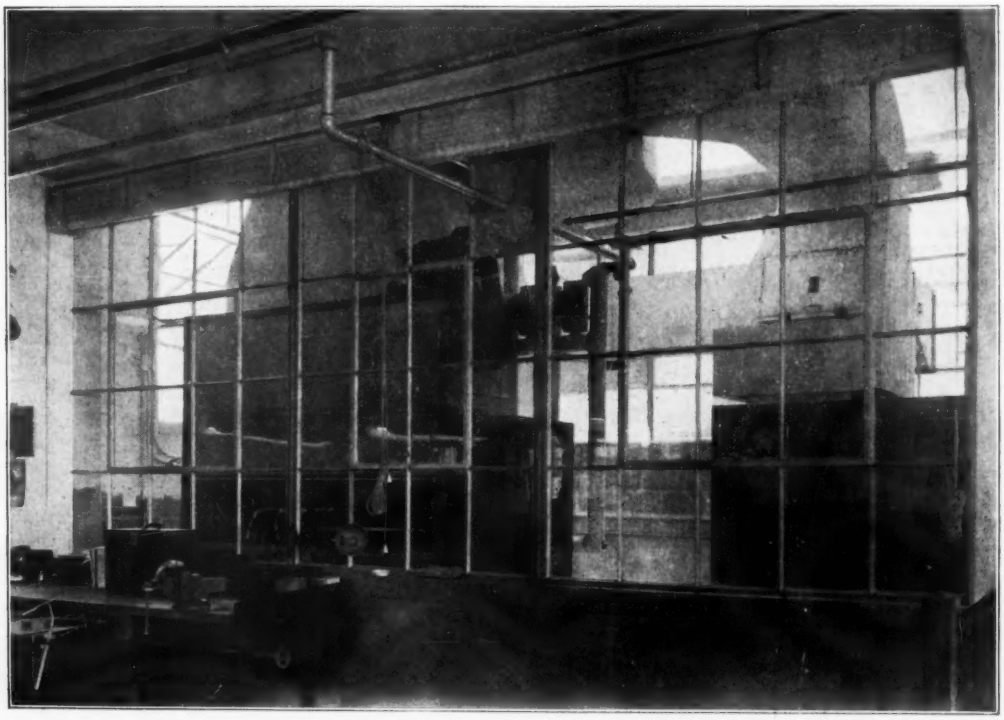
The following methods can be used in removing rustproofing or other oils from steel:

1) Wiping the oil off by hand with a cloth soaked in kerosene.
2) Immersing steel in a hot alkaline solution, or putting steel parts through washing machines containing such a solution.
3) Removing oil by means of a steam jet or steam hose.
4) Dissolving off the oil by organic solvents such as tri-chlor-ethylene.

Special rustproofing oils are particularly useful where storage conditions are poor, where steel is exposed to atmospheric temperature changes and when shipments are to be made in winter when extreme temperatures and humidity changes take place, causing steel to "sweat." They are usually specified by customers in order to meet certain of their storage conditions which may be bad, also to meet their particular methods for removal of the oil.

CONCLUSION

The value of coordinated research has been well demonstrated by the benefits which result when recommended methods of humidity control and rust prevention are adopted. With almost uncanny foresight, the petroleum chemist studied this problem in cooperation with the steel and refrigeration industries. Then he went into the fields of application of precision mechanisms. All the while bearing manufacturers and engine builders were sponsoring their own investigations. When air-conditioning and humidity control became economically available, the cycle was complete. It is gratifying to note that the results of all this research are contributing to the maximum production and protection of defense materiel today.



Courtesy of Carrier Corporation

Fig. 16– The application of air conditioning in the manufacture of aircraft instruments is indicated by the above view.

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TEXACO PRODUCTS

USED IN THE SLUSHING AND RUST-PROOFING OF STEEL

TEXACO NO. 511 OIL

A straight mineral oil, of 200 seconds viscosity S.U. at 100° F., for use where storage and shipping conditions are ideal.

TEXACO NO. 522 OIL

A straight mineral oil, of 100 seconds viscosity S.U. at 100° F., for use where storage and shipping conditions are ideal.

TEXACO NO. 564 RUST PROOF OIL

For use where storage conditions require the use of an oil having high rust proofing qualities. This oil contains a special rust inhibitor and a solvent.

TEXACO NO. 810 OIL

This is an oil of approximately 500 seconds viscosity S.U. at 100° F. It has rust inhibiting properties, and is especially good in bad moisture conditions. Such an oil is easily removed by alkaline washing compounds. It can be cut back with equal parts of a lighter, straight mineral oil (such as Texaco No. 522 Oil) to give a product of lower viscosity, if necessary.

TEXACO NO. 786 OIL

This oil has a viscosity S.U. of approximately 350 seconds at 100° F. Otherwise, the comments shown on No. 810 Oil also apply to this oil.

TEXACO STAZON B AND C

These light greases can be painted or sprayed onto the outside of stacks of sheets and coils to give added protection when stored.

TEXACO SUMMITLUBE NO. 00

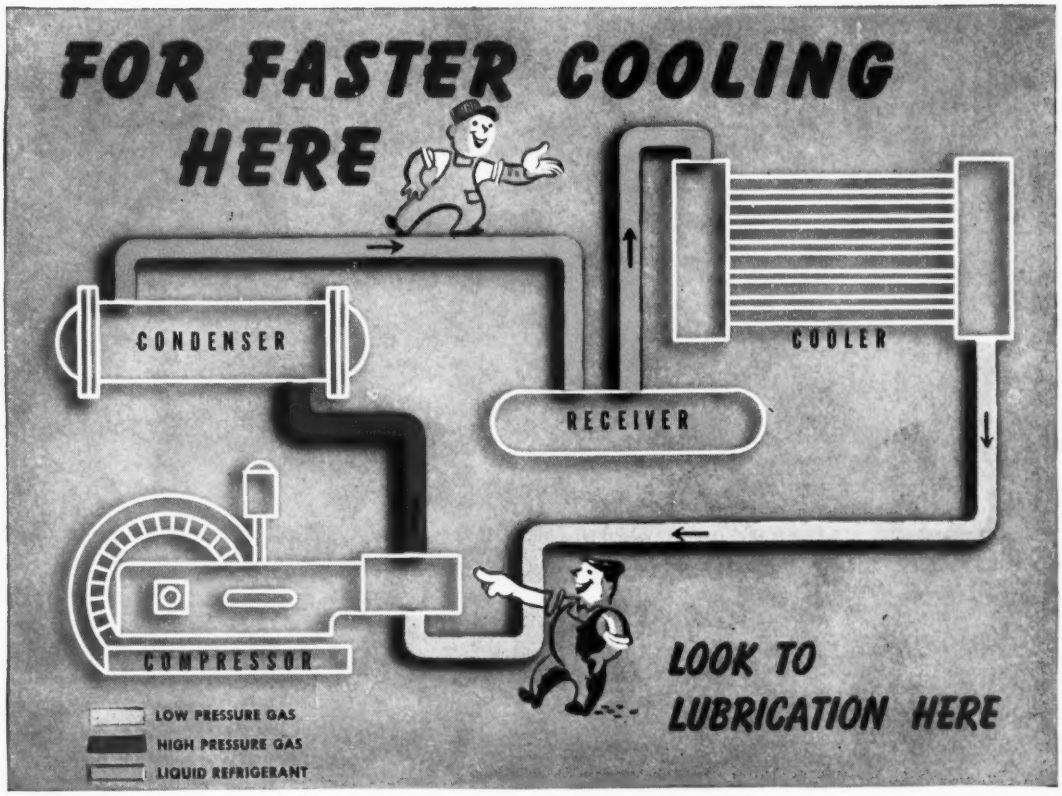
This light grease can also be painted onto the outside of stacks of sheets and coils to give added protection while in storage, but is a little bit too heavy to be sprayed.

TEXACO NO. 1946

This product is soft enough to permit of painting or spraying onto the outside of stacked sheets. It contains a solvent and dries with a slightly tacky moisture-resistant film. It is excellent for coating steel for several months' storage, even when exposed to the elements. If it is too stiff to be handled in cold weather, it can be cut back with as much as 25% of white gasoline, paint thinner or kerosine to give the desired consistency for proper handling.

TEXACO NO. 120 RUST PROOF COMPOUND L

This product is likewise soft enough to be painted or sprayed onto any type of steel which needs protection. It contains a solvent and dries to a slightly tacky, moisture-resistant film. It is quite extensively used as a protective coating for structural steel, railroad and highway steel bridges, and it is also used for coating machinery and other steel parts which are being shipped on the ocean where the salt spray is a factor. This product can likewise be cut back with as much as 25% of suitable thinner to permit application with a spray gun.



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TEXACO

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